ECHAM 5 Global Model Simulations for the NASA TRACE-P Experiment Hongkong and Yokota, March-April 2001

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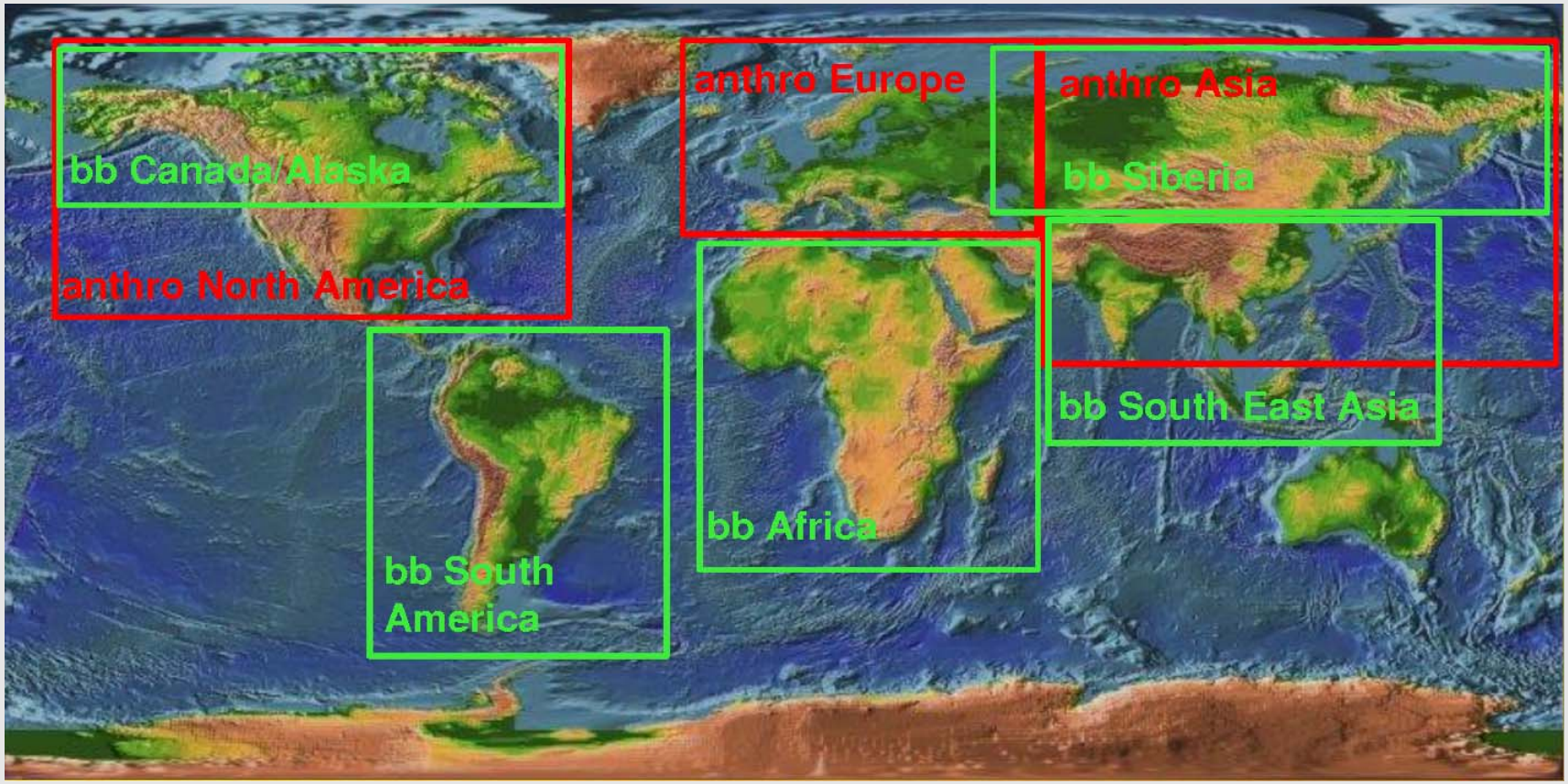
The Model

ECHAM 5 is a new generation general circulation model developed at the MPI-M in Hamburg. The TRACE-P simulations were carried out with a pre-release version.

We developed a simpled tagged CO tracer model for ECHAM which allows identification of 8 individual source regions and an "age of air mass" diagnostic. The CO model uses prescribed OH from Spivakovsky et al., 2000.

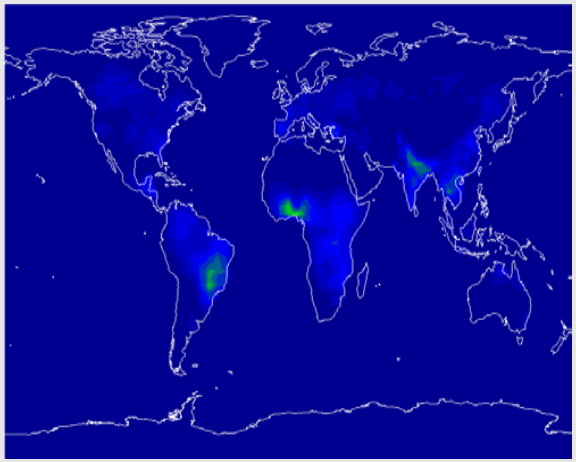
Emission Regions



The Simulations

- During the campaign, we performed 5-day forecast simulations using ECMWF products and computer platforms
- Recently, we ran the model with ECMWF analyses (starting January 2000):
  - run 1: standard 1990 emission data
  - run 2: emissions projected for year 2000 (CDIAC CO_2 and ATSR fire counts)

Improved estimate of biomass burning emissions



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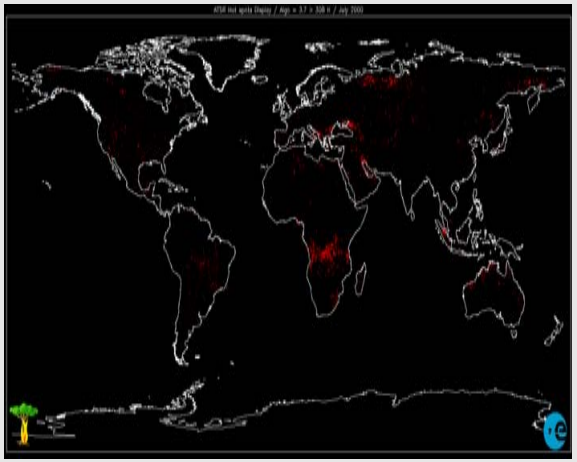

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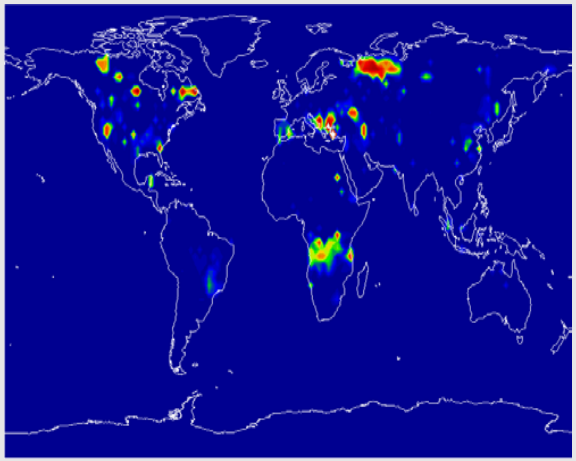

Standard Inventory

Normalized ATSR Fire Counts (monthly)

Time Specific Inventory

Emissions become much more localized!

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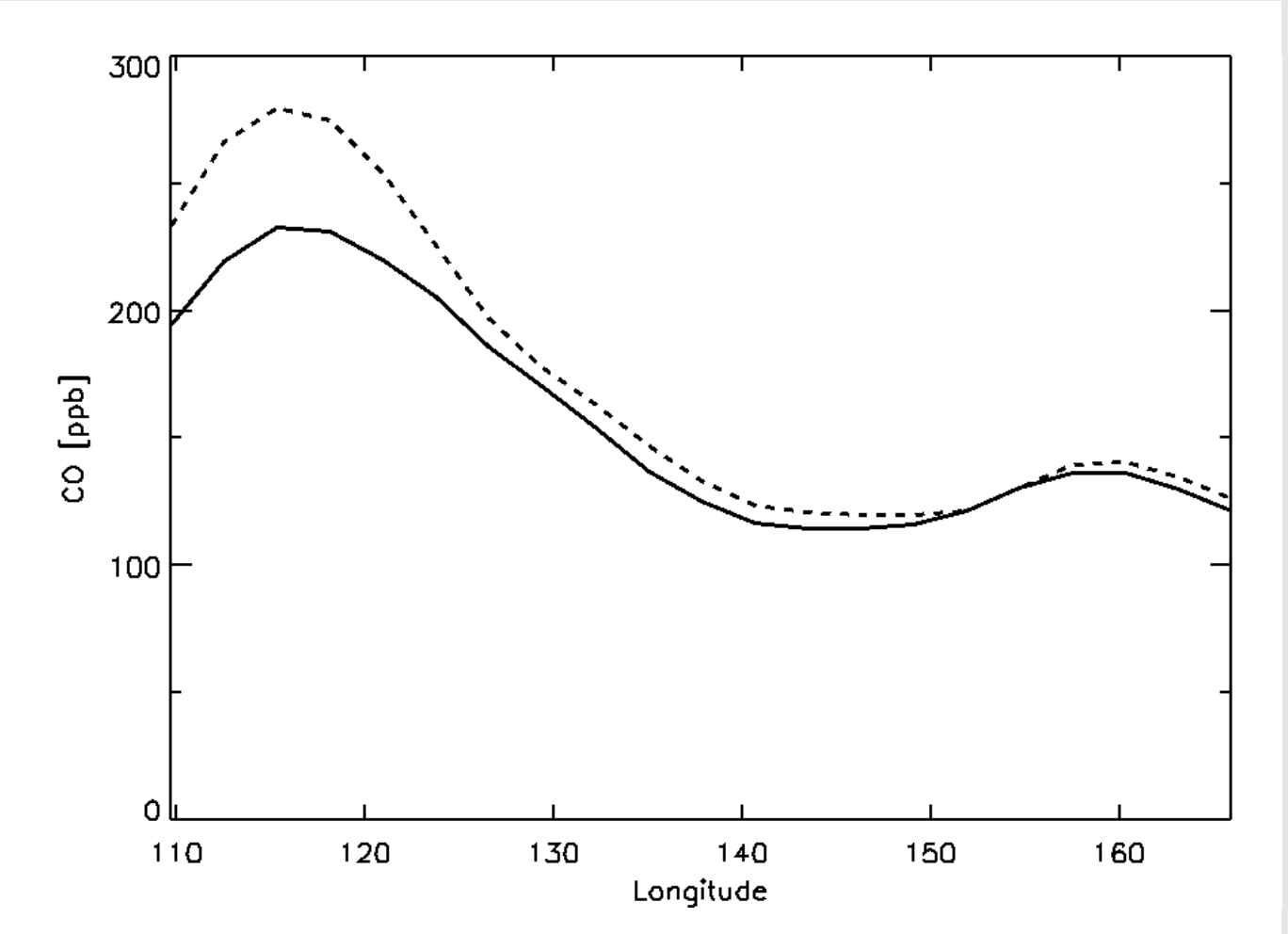
Effect of rescaled emission sources

07 March 2001, 29°N, ~6 km altitude



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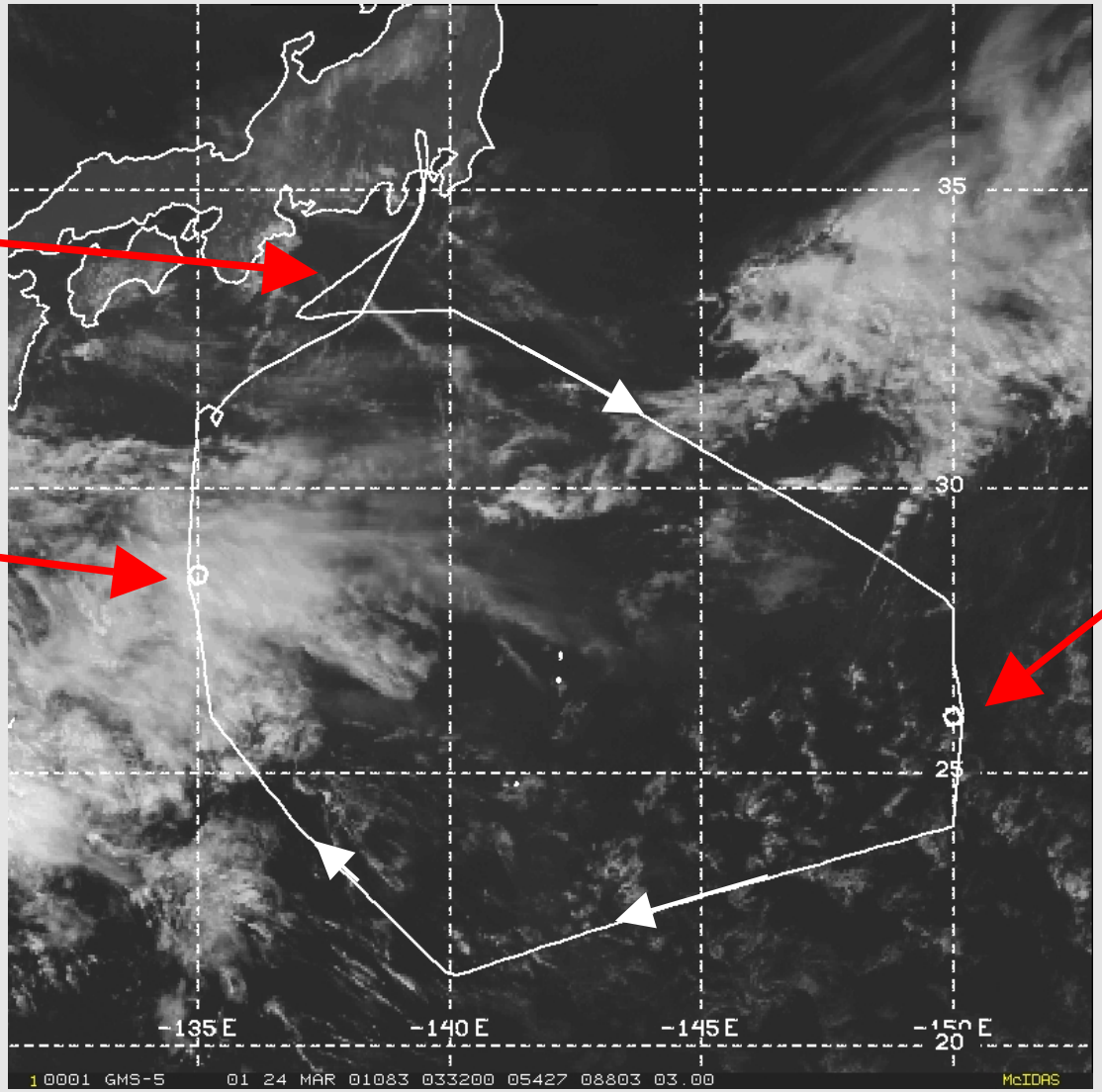
Case study 23 MAR 2001

DC-8 objectives:

- High-altitude outflow from intense convective activity over SE Asia, China, and western Pacific
- High-altitude comparison with P-3B
- MOPITT validation experiment

Case study 23 MAR 2001



inter-comparison

spiral

MOPITT underpass

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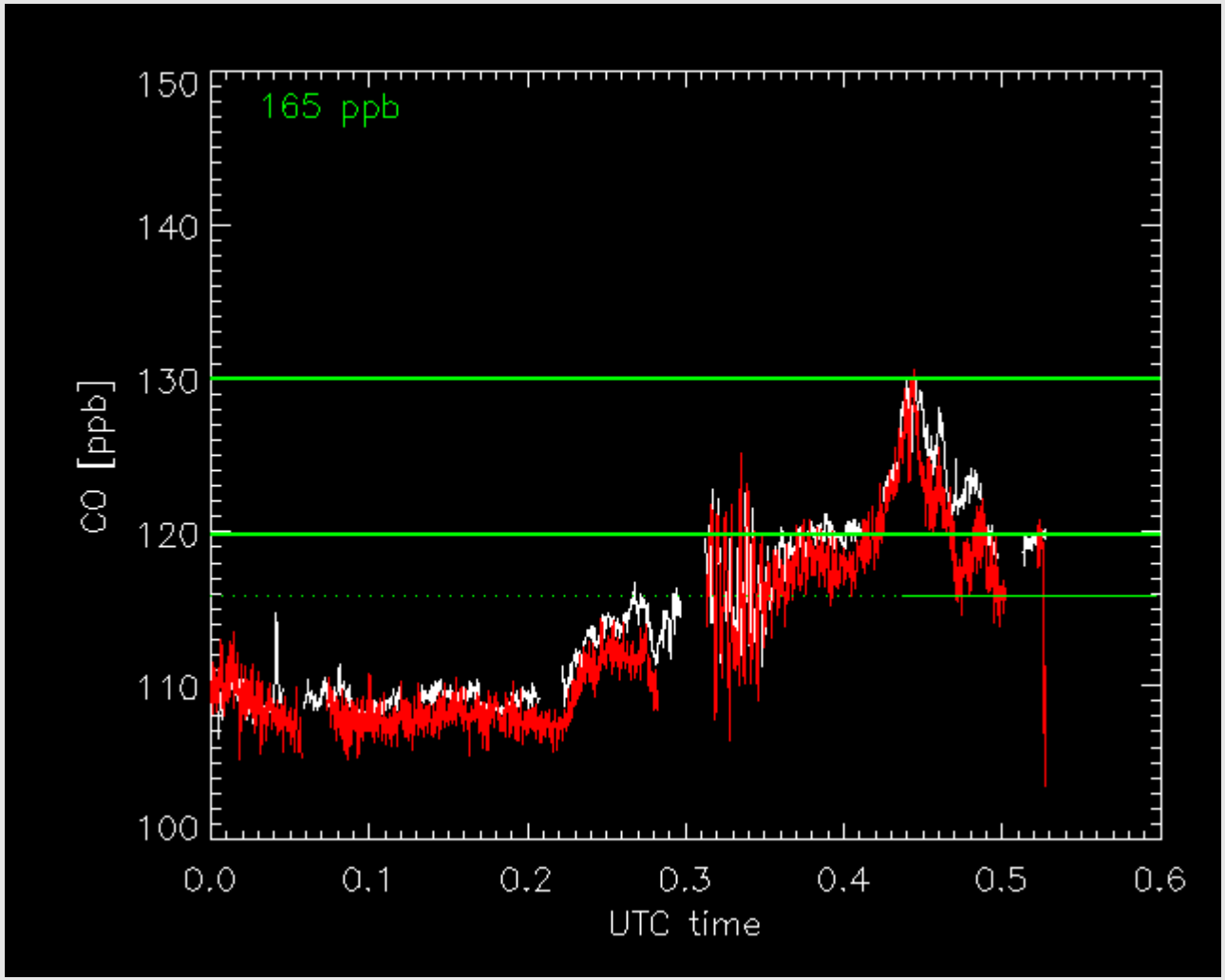
23 MAR 2001: Intercomparison



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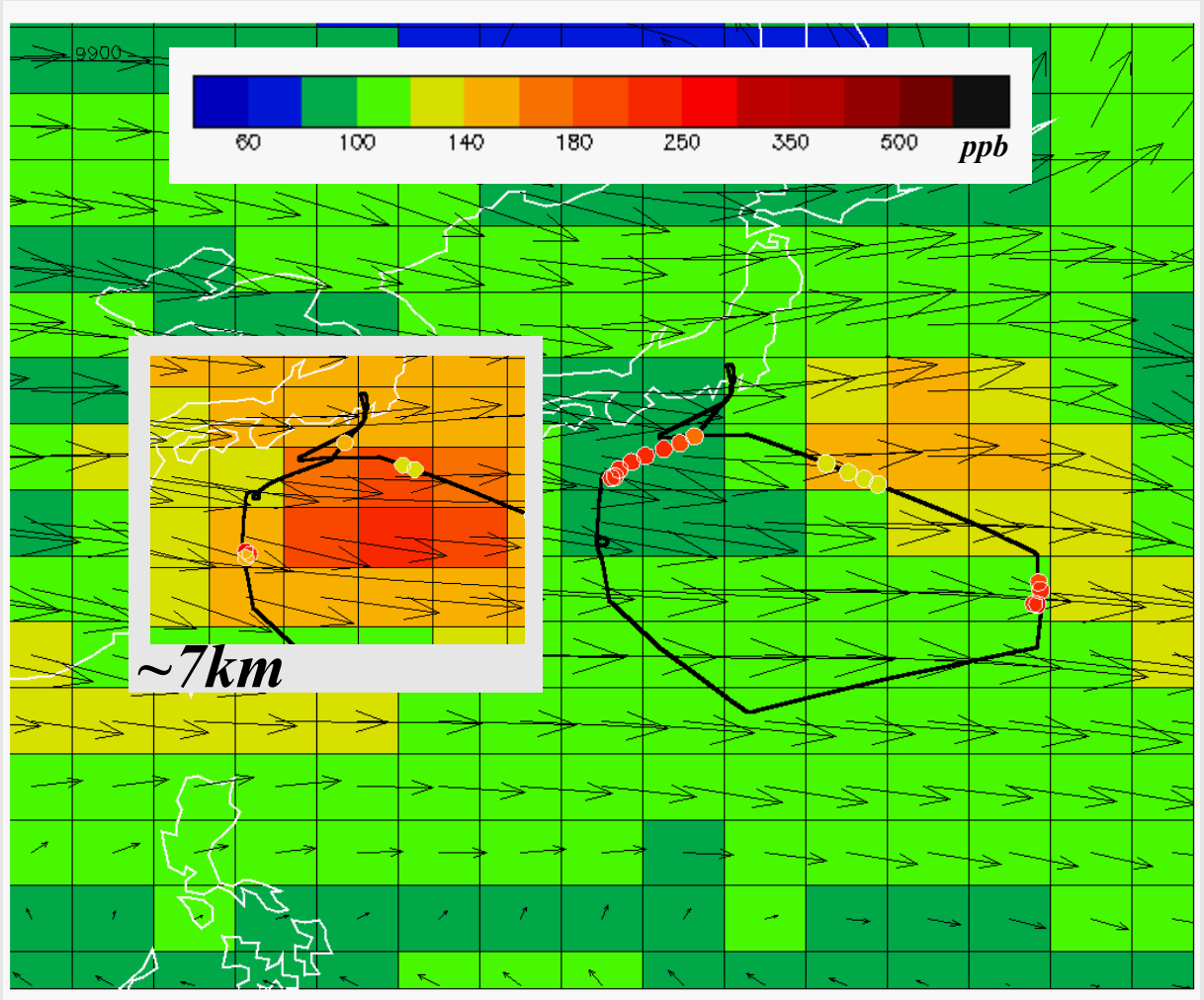
Case study 23 MAR 2001

DC-8 flight 14, P-3B flight 16: Yokota local 2

9-10.4km



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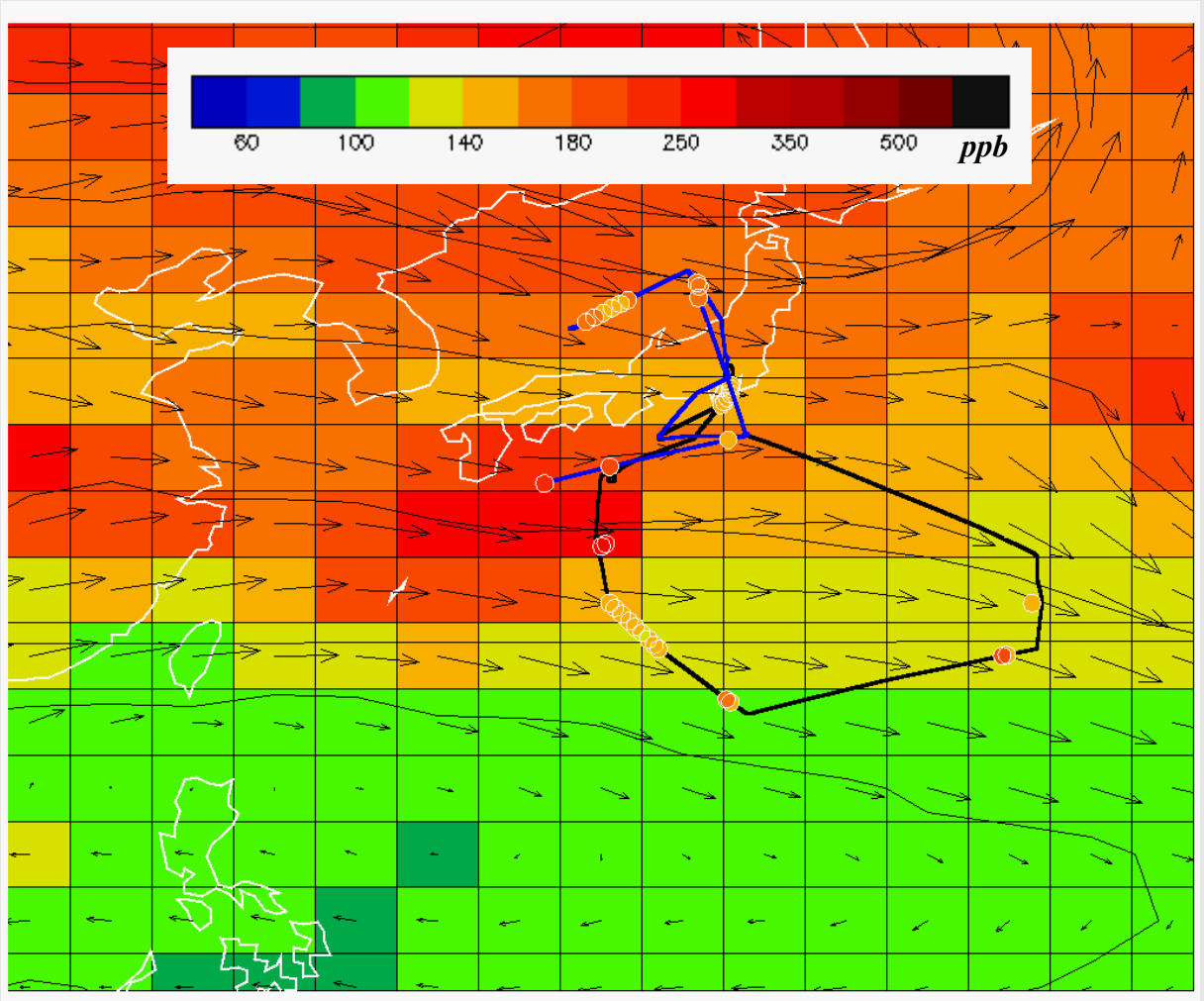
DC-8 flight 14, P-3B flight 16: Yokota local 2

3-4.2km



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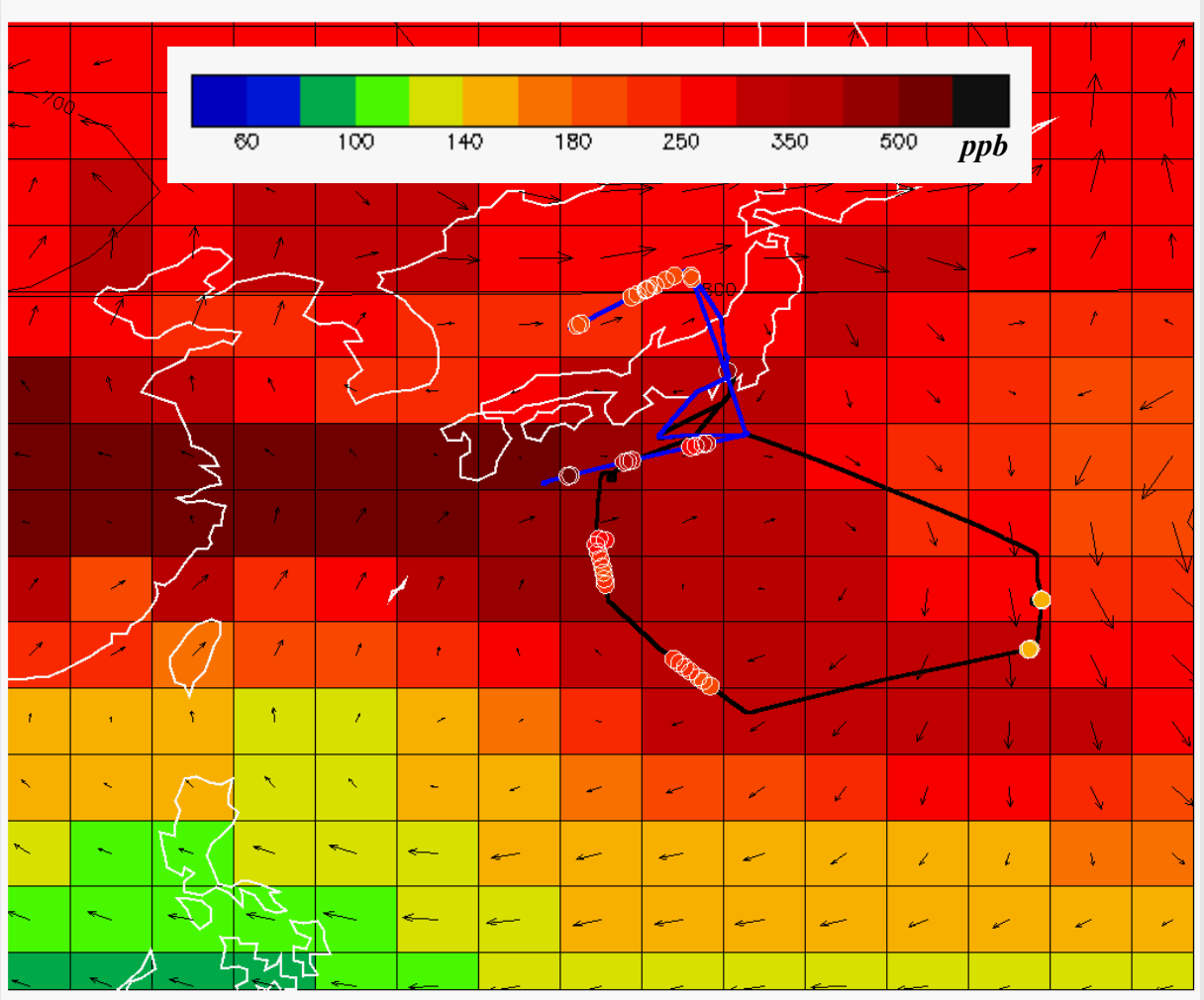
DC-8 flight 14, P-3B flight 16: Yokota local 2

0.3-0.8km



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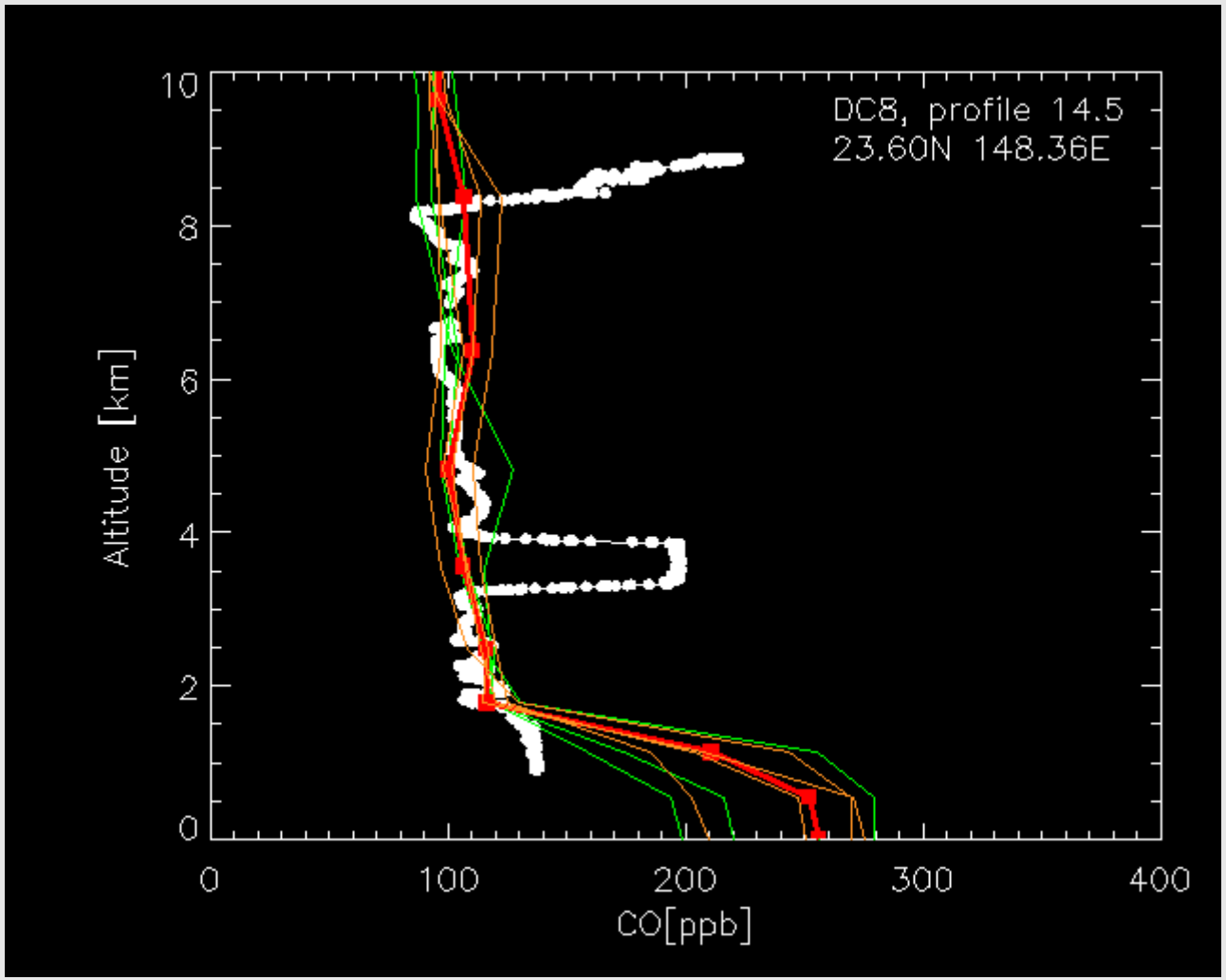
MOPITT underpass spiral (24N, 150E)



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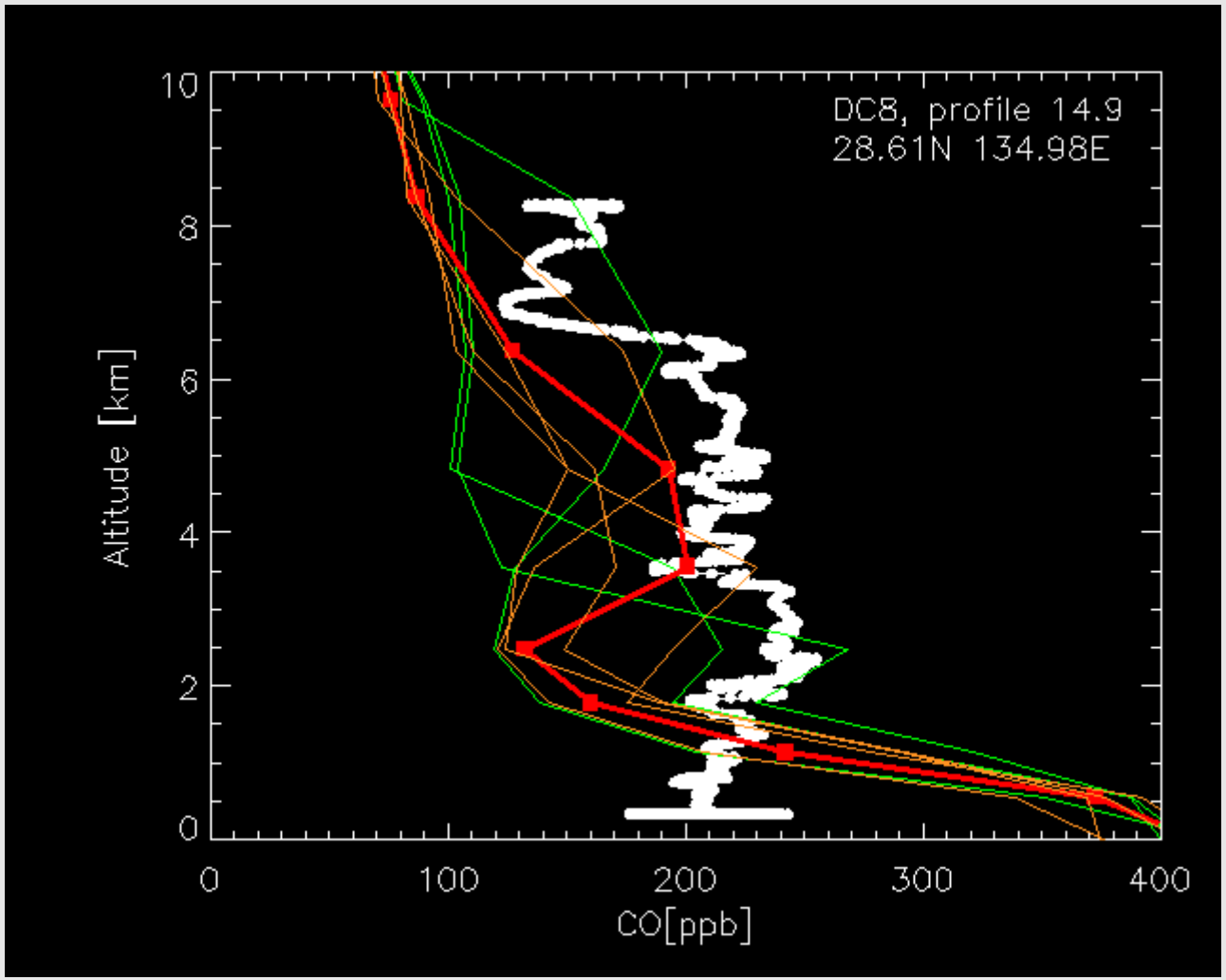
Case study 23 MAR 2001

second spiral (28N, 135E)



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DC-8 Vertical profile analysis

Categories:

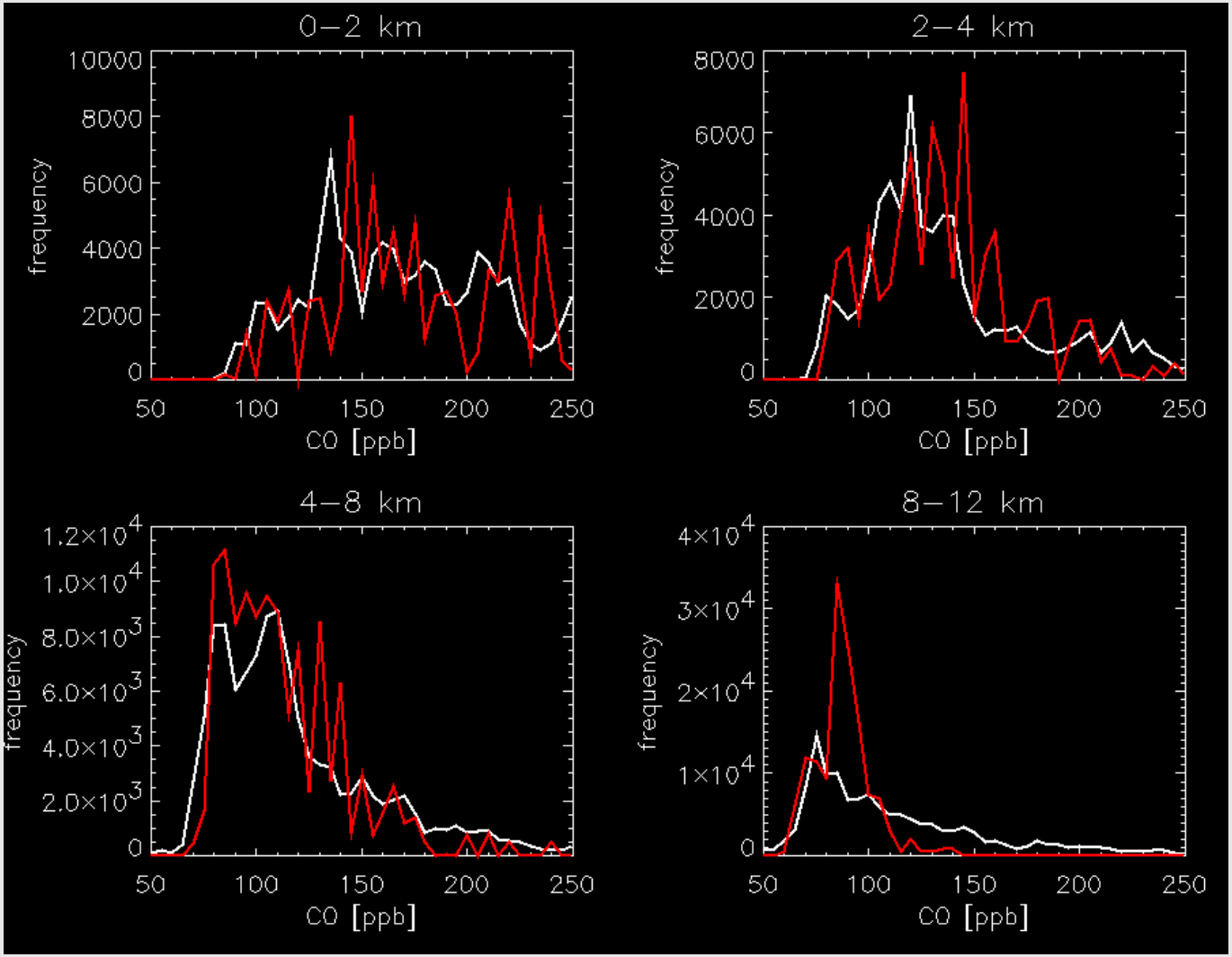
· overall agreement, structureless	*21*	
· overall agreement, with plume	*11*	*35%*
· neighbour box or time-shift	*12*	
· altitude shift (BL)	*6*	*20%*
· missing lower trop. feature	*8*	
· missing upper trop. feature	*21*	*38%*
· not reconcilable	*5*	
· no judgement	*6*	*7%*
total number of profiles	*90*	

Statistical model evaluation

Binned 1-sec CO data [ppb]:

altitude	data	model	diff.
0-2 km	176	193	+10%
2-4 km	146	133	-9%
4-8 km	125	118	-5%
8-12 km	113	90	-20%

Frequency distribution



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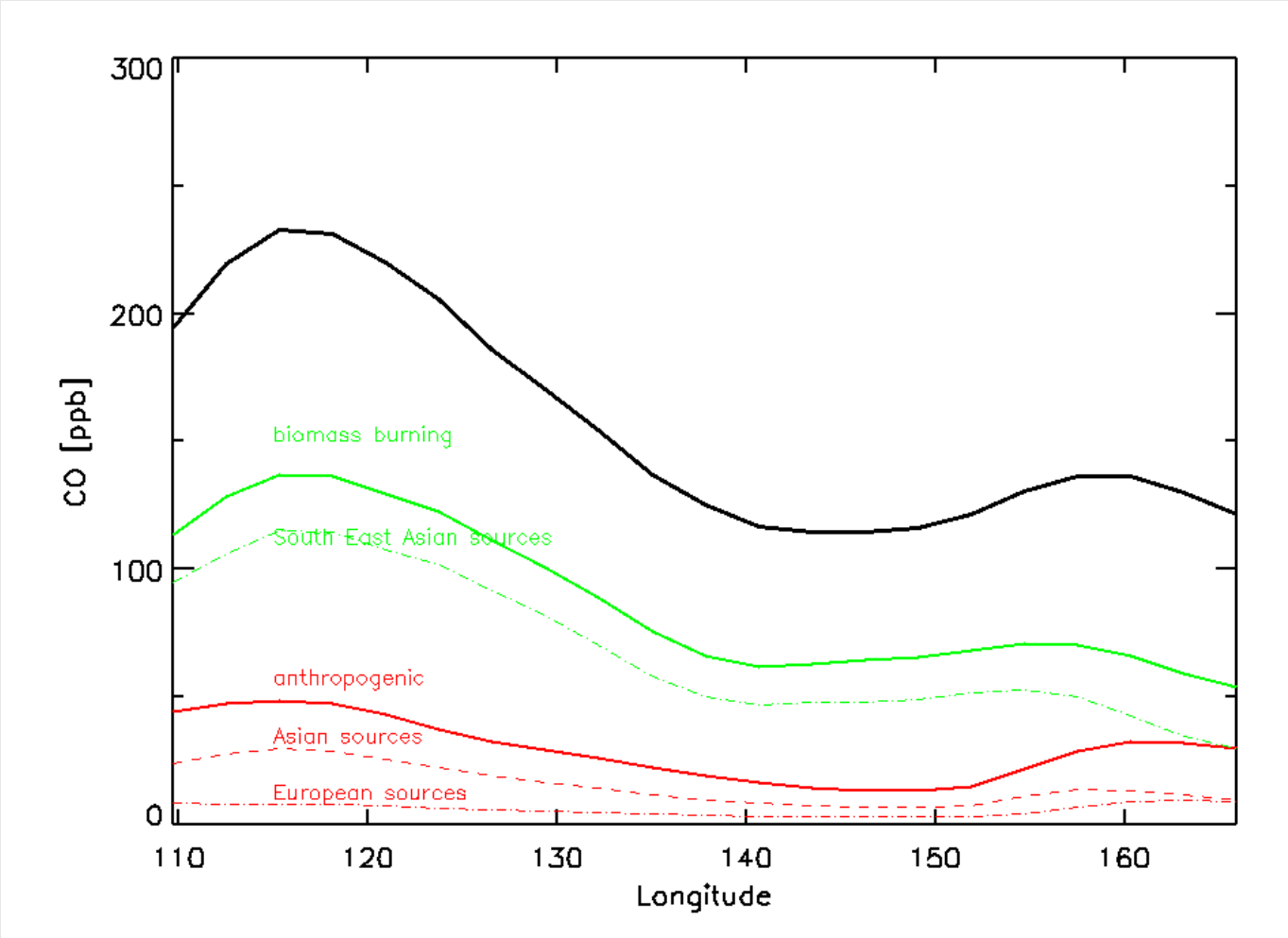
Source Assignment

07 March 2001, 29°N, ~6 km altitude



Estimating the Transport Time

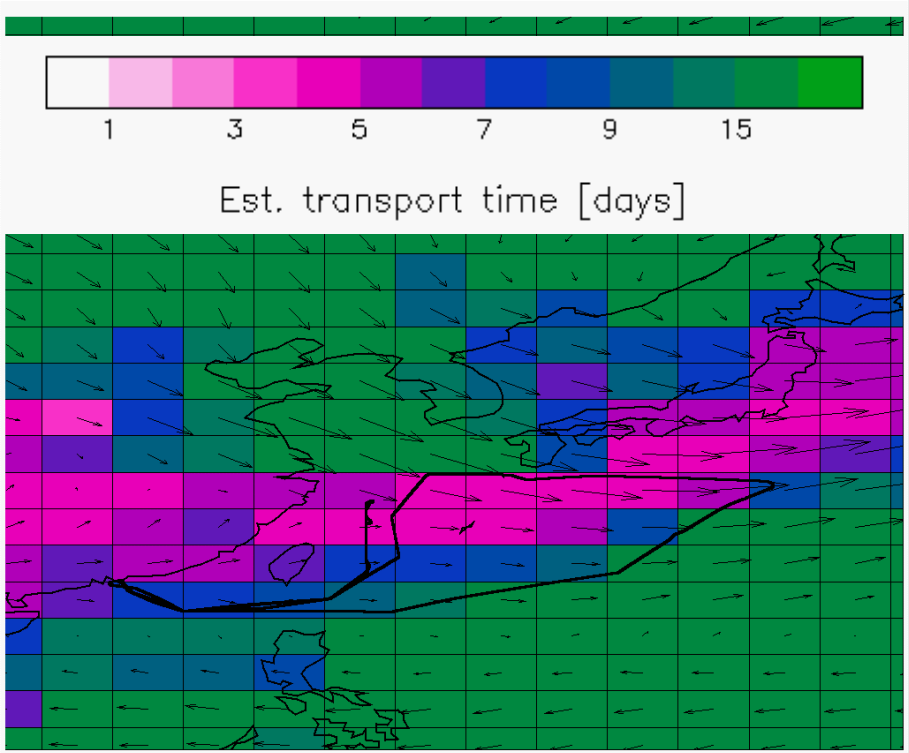
The model has two CO tracers with constant lifetime (5 and 20 days, resp.). The sources of these tracers are identical to the global emission sources of the "real" CO tracers.

$$\frac{C_{5d}}{C_{20d}} = \frac{C_0 e^{\left(-\frac{1}{5d}t\right)}}{C_0 e^{\left(-\frac{1}{20d}t\right)}}$$

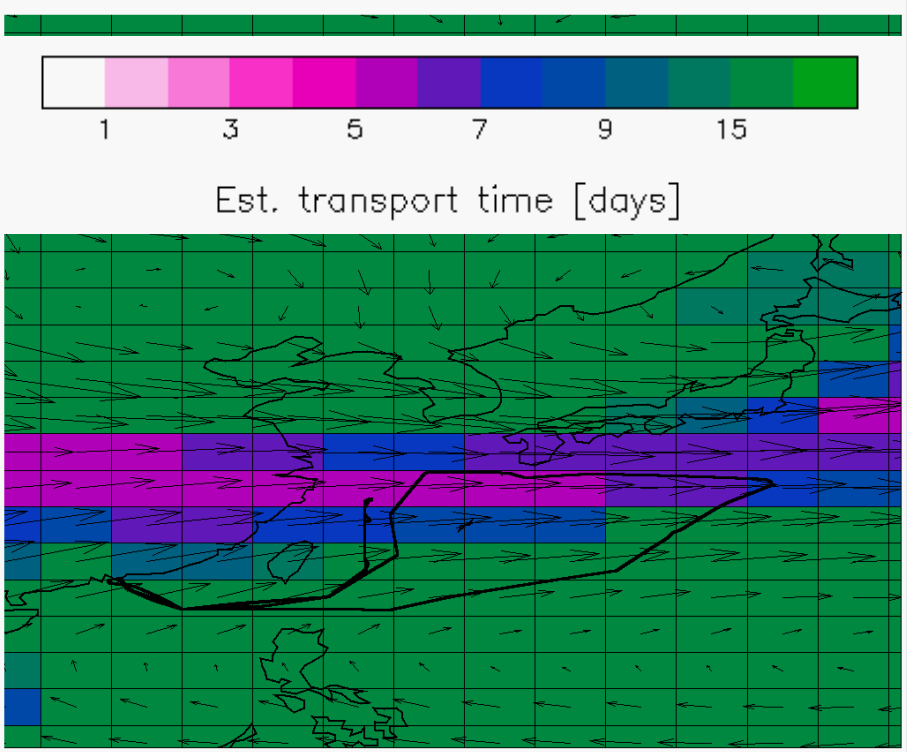
$$t = \frac{20}{3} \ln\left(\frac{C_{5d}}{C_{20d}}\right)$$

Estimated transport time from sources
07 March 2001

1.5-2.1 km altitude



4.2-5.6 km altitude



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Conclusions

- Model has small positive bias in BL, small negative bias in LT, and -20% bias in UT
- CO concentrations on daily basis are reproduced in about 50% of all cases (vertical profiles)
- More localized biomass burning emissions lead to significant enhancement of MT/UT CO. Overall magnitude of emissions reasonable
- UT plumes are often not reproduced. Need to resolve how much of this problem is due to
  - the meteorological data (ECMWF)
  - the parameterisation of convection and BL mixing
  - the model resolution
  - the emission inventory

TRACE-P (paper) plans

- Analysis of model performance (vertical profiles, statistics, and causes)
- Analysis of forecasting errors (forecast quality depending on initialisation date)
- Comparison of TRACE-P CO with ERA-15 period (1979-1993)

Planned model simulations

- T42: finally using emissions from Streets et al.
- T106 L30+: adressing the resolution problem